



Three Early Symposia Showing the Direction for the Evolution of Gas Chromatography

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This article discusses the beginnings of gas chromatography in England and the first three major European symposia that played important roles in the dissemination of gas chromatography.

It often is stated that the evolution of gas chromatography was, and still is, characterized by frequent meetings. Indeed, the frequently organized international symposia played an important role in the rapid dissemination of the technique and still are serving as the places where the newest developments are reported.

Gas chromatography (GC) started its meteoric rise with the three seminal papers of A.J.P. Martin and A.T. James, published in 1952. First used only by a few laboratories, within a few years the interest was so great that after an initial one-day symposium in England in 1955, two international symposia could be held in 1956 and 1958. Gas chromatography also spread rapidly in the US. The first representative GC symposium was held in April 1956, during the 129th National Meeting of the American Chemical Society, in Dallas, Texas, USA. Over 600 chemists participated at the symposium where 20 original papers were presented. From then on the Instrument Society of America took over the organization of major GC symposia which were held biannually between 1957 and 1963 in East Lansing, Michigan, USA.

Today, more than 40 years later, the papers presented at these symposia provide us a good basis to understand how GC evolved. Even for present-day chromatographers it is highly

beneficial to study the proceedings of these symposia, including not only the presented papers but also the transcripts of the extensive discussions.

In this article, I will report on three European symposia that set the stage for future development. As a brief introduction I shall outline the events that led to these symposia and explain the role of individuals and associations involved in their organization.

The Start of GC in England

A.J.P. Martin and A.T. James first presented a preliminary report on the new technique at the 290th meeting of the British Biochemical Society, on 20 October, 1950.¹ After some additional work, they submitted in the second part of 1951 three fundamental papers on the theory of the technique and its applications for the separation of the lower fatty acids, volatile amines and pyridine homologues.²⁻⁴ These papers were published in 1952, in *Biochemical Journal*.

After successfully separating these biochemically important substances, Martin wanted to investigate the separation of some other closely related volatile compounds, and hydrocarbons seemed to be an obvious choice. However, the British National Institute for Medical Research, Martin's

workplace, obviously did not have pure hydrocarbon samples; so, he had to find an institution which could supply them.

During World War II an organization was established in England to prepare pure reference hydrocarbons and this organization, the Hydrocarbon Research Group operating within the Institute of Petroleum (IP), continued its function even after the war. At that time the head of its Hydrocarbon Chemistry Panel was Dr S.F. Birch, a research manager at British Petroleum Co. (BP) at its Sunbury-on-Thames laboratories. Therefore, in the early summer of 1952 Martin wrote him requesting some samples. Dr Birch sent Denis H. Desty, one of his young associates, to visit Martin in order to determine the reason for the request. When learning about the work of Martin and James, Desty immediately recognized the great potential of GC for petroleum chemists and he became the driving force in spreading its use.

Meanwhile, the First International Congress on Analytical Chemistry was held 4–9 September, 1952, in Oxford, UK, where Martin presented a major paper on GC.⁵ H. Boer of the Shell Research Laboratories in Amsterdam, who was present at the meeting called it “an historical lecture”⁶ and indeed, this was true. The Congress was attended by nearly 700 people from 26 countries, including representatives of the most important industrial and research laboratories. The participants returned home excited by the potential of the new technique.

The first laboratories active in GC primarily were of the petroleum companies and of the Imperial Chemical Industries (I.C.I.). In fact, chemists at I.C.I. learned about GC through visits to Martin’s laboratory well before the publications by James and Martin. Thus, soon after their publication, the first papers on the application of GC were authored by chemists from I.C.I.^{7–10}

The first representative symposium in the UK dealing exclusively with gas chromatography was organized on 20 May 1955, by the Physical Methods and Microchemistry Groups and the Scottish Section of the Society for Analytical Chemistry; it was held in Ardeer, North Ayrshire, UK and hosted by I.C.I.’s Nobel Division. The participants at this meeting felt that the speed of progress was so rapid that the time was ripe for a large meeting with international participation, in order to survey the newest developments. The Hydrocarbon Research Group agreed to sponsor this symposium which took place 30 May–1 June, 1956, in London, UK. Following this Symposium a new organization, the Gas Chromatography Discussion Group (GCDG), was formed and it decided to organize two years later a similar symposium, at that time in Amsterdam. This meeting took place 19–23 May, 1958, with an even greater interest. From then on the group (later renamed The Chromatographic Society) continued to organize such biannual symposia, a series that is still alive; the most recent, the 24th International Symposium on Chromatography, was held in Leipzig, Germany, in September 2002.

These three symposia, the papers presented there and the extensive discussions had a most significant impact on the evolution of GC, particularly since the material of the symposia was generally available soon after the meetings. The abstracts of the papers presented at the Ardeer symposium were published in *Analytical Chemistry*¹¹ and a detailed report was also provided in *The Analyst*.¹² In the cases of the 1956 and 1958 symposia, the preprints were sent in advance to the participants and a few months after the meetings the final text of the papers

and the transcript of the discussions were published in book form.^{13,14} My present report is based on this literature.

The Ardeer Symposium

About 130 analytical chemists attended this meeting. Besides five formal papers presented by A.J.P. Martin, E. Chalkey (I.C.I. Billingham, Cleveland, UK), A.B. Littlewood and C.S.G. Phillips (both Merton College, Oxford University, UK) and N.H. Ray (I.C.I. Winnington, Cheshire, UK) extensive discussions were held and a demonstration of home-built gas chromatographs was also included in the programme.

Martin summarized some of the rules influencing column efficiency and surveyed the various possibilities for detecting devices, with special emphasis on those measuring thermal conductivity and his newly developed gas density balance. He also formulated the linear relationships between the logarithm of the retention volumes of members of homologous series and the number of carbon atoms in their molecules. Chalkey continued the discussion of the analysis of hydrocarbon mixtures first presented on 10 November 1954 at the Institute of Petroleum,¹⁰ now concentrating on the analysis of C₁–C₄ hydrocarbons and the quantitative aspects of analysis. Littlewood elaborated on the possibility of the analysis of boron and silicon hydrides, while Phillips compared GC in the adsorption and partition modes and discussed the possibilities of thermodynamic calculations using retention volumes. Finally, Ray described an ingenious way of determining non-olefinic impurities present in ethylene, using a Janák-type gas chromatograph.¹⁵

After Martin’s paper E.F.G. Herrington (Chemical Research Laboratory, Teddington, Middlesex, UK) presented relationships for the vapour pressures and other physico-chemical constants versus retention volumes and the carbon number of members of homologous series. He also illustrated the linear relationship of the logarithms of retention volumes of homologues measured on two different stationary phases.

A major part of the programme of the Ardeer symposium comprised of a discussion session dealing with the construction and characteristics of thermal-conductivity detectors. The discussion was opened by A.I.M. Keulemans (Shell Laboratories, Amsterdam, The Netherlands) who enumerated the requirements for such detectors and described the construction of devices developed at Shell. A number of other participants also described their own home-built systems (made of glass or metal) and their experiences in their use.

Table 1: Distribution of the papers presented at the 1956 London symposium.

| Presenter affiliation | Number of papers | Percentage of papers (%) |
|----------------------------------|------------------|--------------------------|
| Petroleum and related industries | 14 | 41.2 |
| Other industrial laboratories | 10 | 29.4 |
| Universities | 4 | 11.8 |
| Government laboratories | 5 | 14.7 |
| Scientific instrument industry | 1 | 2.9 |
| Total | 34 | 100.0 |

The 1956 London Symposium

This Symposium on Vapour Phase Chromatography (as the technique was then called) was organized by Desty, assisted by C.L.A. Harbourn, his associate at BP. Nearly 400 scientists from 13 different countries attended the meeting and a total of 34 original papers was presented. Of these, 23 (67.7%) were by British authors. Of the papers presented by foreign scientists, three were from The Netherlands, two of each from the US and Czechoslovakia, and one of each from Canada, France, Hungary and New Zealand. In addition, both Martin and James addressed the Symposium: Martin spoke about “trends in GC,” predicting some future developments, while James surveyed the various detection methods, presenting also some ideas for the future.

Table 1 lists the distribution of the papers presented at the symposium. The overwhelming majority of the speakers came from the petroleum industry and of the 14 papers, six were presented by chemists from the Shell laboratories in the UK and The Netherlands. Among speakers from industrial laboratories, four came from I.C.I. It is interesting to survey the papers presented at the symposium because it provides insight to the state of GC just four years after the seminal papers by James and Martin.

Probably the two most important papers were presented by E.F.G. Herrington (Chemical Research Laboratory, Teddington, Middlesex, UK) and by A.I.M. Keulemans and A. Kwantes (Shell Laboratory, Amsterdam, The Netherlands). Herrington's lecture represented a detailed discussion of the thermodynamics of GC. In it he further elaborated on the relationships already mentioned one year earlier at the Ardeer symposium, but now in a more formal way, with examples. Keulemans and Kwantes presented a thorough discussion of the rate theory and what we call today the Van Deemter equation. At that time the fundamental paper of J.J. van Deemter, F.J. Zuiderweg and A. Klinkenberg was not yet published¹⁶ and thus, this was the first time that chromatographers were exposed to the details of this fundamental relationship. For present-day chromatographers the conclusion of this presentation might be interesting: the speakers postulated that, by optimizing the column parameters and operating conditions, one might be able to achieve a plate height (HETP) of 2 mm which assuming a 20 m long (packed) column, would give 10 000 theoretical plates.

The paper of C.M. Drew and J.R. McNesby (US Naval Ordnance Test Station, China Lake, California, USA) dealt with the effect of the operational parameters on the GC results. Temperature programming first was described in 1952 by J.H. Griffiths, D.H. James and C.S.G. Phillips;¹⁷ now, Drew and McNesby also utilized this technique. In the field of stationary phases the thorough discussion of the various polyglycols with different molecular weights by E.R. Adlard (Shell Research Centre, Thornton, Cheshire, UK) should be emphasized. Even today, these polar phases are used widely and the information presented in this paper is still of interest to us.

J. Janák (Institute of Petroleum Research, Brno, Czechoslovakia) described the characteristics of zeolites (molecular sieves) as adsorbents for the analysis of C₁–C₄ hydrocarbons. In another paper he dealt with the concept of the so-called chromatographic spectrum, a scale based on the specific retention volumes. This probably was the first systematic discussion of the differences in separation on polar vs non-polar stationary phases and different adsorbents (silica gel,

active carbon, zeolites). An important aspect pointed out in the discussion was the role of the carrier gas when using adsorbents as the stationary phase. In his system¹⁸ Janák was using carbon dioxide as the carrier gas, and the behaviour of these adsorbents is quite different in such a case. For example, C₂–C₃ saturated/unsaturated hydrocarbons cannot be separated on the zeolites when using hydrogen and nitrogen (or helium) as the carrier gas, but their separation is possible using carbon dioxide.

In 1956 the most frequently used detector was the katharometer (thermal-conductivity detector). In addition, three other detectors had a limited use: the automatic titrator of James and Martin,² the hydrogen flame (thermocouple) detector of R.P.W. Scott (Benzole Producers, Watford, Hertfordshire, UK) first reported in 1955¹⁹ and Martin's gas density balance which at the time of the symposium was not yet described in a journal publication. (A description was finally published soon after the Symposium²⁰). Now Scott further elaborated on his detector and C.W. Munday and G.R. Primavesi (The Distillers Co., Epsom, Surrey, UK) described their experience with the density balance, pointing out some of its shortcomings. At that time these detectors represented a possible alternative to the katharometer; however, within two years the development of the ionization detectors made them obsolete.

The scientific instrument industry was still in its infancy in 1956 and all the investigations reported at the symposium were carried out on self-constructed instruments which were briefly described in the papers. Four papers specifically dealt with the design and performance of gas chromatographs: J.C. Hawkes (Monsanto Chemicals, Ruabon, Wrexham, UK) discussed an instrument equipped with the gas density balance as the detector and J. Brooks, W. Murray and A.F. Williams (I.C.I. Nobel Division, Stevenson, North Ayrshire, UK) described a GC system with a special inlet permitting the selective evaporation of only a part of the sample (a precursor of present-day programmed-temperature (PTV) injectors!). Particularly interesting was the description of a preparative gas chromatograph by B.T. Whitham (Shell Research Centre, Thornton, Cheshire, UK) using 27-ft long packed columns of 1/2 in. diameter, with a column packing consisting of 44/52 mesh support particles coated with 26% silicone oil. The maximum operating temperature was 300 °C and the liquid sample volumes varied between 0.01 and 3.0 mL. Finally, H.H. Hausdorff (PerkinElmer, Norwalk, Connecticut, USA) described the Model 154, the company's gas chromatograph introduced in 1955 which at that time was still unknown in Europe.

Several papers dealt with the application of GC in a wide variety of fields such as the analysis of fatty acids and fatty alcohols, chlorocarbons and fluorocarbons, industrial solvents and hydrogen isotopes. These papers demonstrated how widespread GC had become in only four years.

Finally I should mention that some papers discussed questions that were relevant at that time, but are mostly forgotten today. For example, a number of chromatographers advocated the use of reduced column outlet pressure. Even Martin, in his introductory lecture, indicated the possible improvement in the sensitivity of the katharometer if used at subambient pressure. Another question discussed was the selection of the carrier gas with this detector. At that time helium was practically unavailable in Europe, so most

chromatographers used nitrogen, which did not permit the full utilization of the detector's sensitivity due to the relative closeness of the thermal conductivities of nitrogen and organic vapours. A further question connected to this detector was its quantitative response; chromatographers were not sure about the best way the response factors could be established and whether calculation as weight or as volume per cent was to be preferred. Although these questions have long since been settled, it is interesting to read the discussions 46 years ago, presenting a good base to understand the state of GC in the mid-1950s.

At the beginning of the symposium a committee was established that presented its recommendations for proper chromatographic nomenclature and for the universally applicable general relationships. The use of gas chromatography instead of vapour phase chromatography was approved unanimously and a list of standard phases and test substances to be used as standards was established. It is interesting to note that this was the first time that the compressibility correction factor was given as a separate term, however, it was called a reducing factor: its present name was introduced only later. A shortcoming of this committee's recommendation was the confusion of the terms *efficiency* and *resolution*. This problem was corrected two years later, at the Amsterdam Symposium.

The 1958 Amsterdam Symposium

This symposium was organized by the Gas Chromatography Discussion Group together with the Royal Dutch Chemical Society and held May 19–23, 1958 in Amsterdam, in the Royal Tropical Institute. The secretary of the joint organizing committee was G. Dijkstra (Unilever, Vlaardingen, The Netherlands), and Desty was in charge of editing the submitted papers and preparing the preprints and the final proceedings.¹⁴ Nearly 500 participants from 18 different countries attended the symposium, the most memorable in the Group's long series of biennial meetings. For me, this symposium also evokes personal memories because it was the first I attended. A total of 28 papers were presented: from these 15 (53.6%) were by British authors and four (14.3%) by Dutch authors. Chromatographers from Germany and the US presented two papers each, while authors from Australia, Belgium, Czechoslovakia, Italy and the Soviet Union presented one paper each. Brief addresses were presented by J.J. van Deemter (Shell Laboratory, Amsterdam, The Netherlands), A.J.P.

Martin and P.H. Emmett (Johns Hopkins University, Baltimore, Maryland, USA).

The organization of the meeting was slightly different than of the meeting in London, two years earlier. Because now the papers were preprinted well before the meeting and mailed to the participants, the authors only presented a brief summary and some additional information not included in the printed text. This new material then was printed in the final proceedings as "authors' additional comments," and in many cases, represented important additions to the original printed text. Each paper was followed by a very intensive discussion and some of the remarks almost can be considered as mini-lectures. At the end of the proceedings, the list of persons participating in the discussions is given. The intensity of the discussions is best demonstrated by the fact that a total of 77 people participated in them; that is, more than 15% of the participants had an active role in the meeting.

Table 2 presents the distribution of the papers according to the field of the speakers. As can be seen the earlier dominance of the petroleum industry was reduced although still remained substantial. It is interesting to observe the significant increase of papers from universities: their number, when added to those from government laboratories, was now equal to the number of papers from the petroleum industry. The papers were presented in three groups: theory (10 papers), techniques and apparatus (9 papers) and applications of GC (9 papers). Again, a Nomenclature Committee was formed which reported to the symposium. It reviewed the draft of two papers on the way GC data should be presented and on the definition of some terms; after some modifications these papers were published soon after the Symposium.^{21,22} The committee clarified the difference between efficiency (plate number) and peak resolution, and introduced for the latter the formula

$$R_s = \frac{2(t_{R2} - t_{R1})}{w_{b1} + w_{b2}} \quad [1]$$

where t_R is the retention time and w_b is the peak width at base.

Without any question the two most important papers were those by I.G. McWilliam and R.A. Dewar (I.C.I. of Australia and New Zealand, Melbourne, Australia) and by M.J.E. Golay (Perkin-Elmer, Norwalk, Connecticut, USA). These papers have changed the way GC has been carried out ever since. The first described the flame-ionization detector (FID) while Golay presented the theory of open-tubular columns. McWilliam's work already had been known to some participants from a brief description he presented in October 1957 at an informal meeting of the GC Discussion Group, in Cambridge, UK, and published as a short paper in *Nature*.²³ Thus, following his presentation at the symposium H. Boer (Shell Laboratory, Amsterdam, The Netherlands) already could report on their results with this detector. The ensuing discussion between the two and McWilliam's answers to Golay's questions (who immediately recognized that the FID was the ideal detector for his columns) further qualified a number of practical questions.

Golay had already presented a crude theory of the open-tubular (capillary) columns one year earlier, at the 1957 Lansing Symposium of the Instrument Society of America.²⁴ However, that paper cannot be compared to this presentation, which gave a most complete theory, more elaborate than the Van Deemter equation was for packed columns. (The original form of Van Deemter's theory and equation described at the

Table 2: Distribution of the papers presented at the 1956 Amsterdam symposium.

| Presenter affiliation | Number of papers | Percentage of papers (%) |
|----------------------------------|------------------|--------------------------|
| Petroleum and related industries | 9 | 32.2 |
| Other industrial laboratories | 7 | 25.0 |
| Universities | 7 | 25.0 |
| Government laboratories | 2 | 7.1 |
| Scientific instrument industry | 3 | 10.7 |
| Total | 28 | 100.0 |

Without any question the two most important papers at the 1958 Amsterdam Symposium were those by I.G. McWilliam and R.A. Dewar and by M.J.E. Golay.

1956 Symposium by Keulemans and Kwantes and in the detailed publication¹⁶ neglected resistance to mass transfer in the gaseous phase). As published in the preprints, in which 92 equations were crammed into 16 printed pages, Golay's paper would probably have created little attention; as noted by Desty, it "was totally beyond almost all the participants of the symposium."²⁵ The sensation was created by Golay's additional comments in which he showed two chromatograms obtained on the new capillary columns: the separation of all the C₆ hydrocarbons in less than 9 min, and the resolution of *m*- and *p*-xylenes. A 150 ft (45.7 m) long column, with an i.d. of 0.25 mm and coated with dodecyl phthalate was used in both cases, and over 50 000 theoretical plates were obtained using a flow-rate of 0.5 mL/min. These results were even more remarkable because they were obtained using a micro thermal-conductivity detector specially constructed by Golay for this purpose. It was immediately clear at the symposium that McWilliam's FID would be the ideal detector for such columns. The general feeling was best described by Desty, reminiscing about his own reaction: "we dashed back from Amsterdam to set up a capillary column apparatus within a few days...(consisting of) the very versatile hydrogen flame (ionization) detector described by McWilliam...(and using) thick-walled lengths of 50 metres of stainless steel tubing."²⁶

It should be mentioned that G. Dijkstra and J. de Goey (Unilever, Vlaardingen, The Netherlands) also presented a paper on coated capillary columns at the symposium. It discussed the potentials of such columns, without any theoretical treatment; however, the actual results were very poor: the maximum efficiency obtained for a 120 metre long, 0.3 mm i.d. column was only 2500 theoretical plates. It was pointed out in the discussion that these extremely poor results were obviously due to too large volumes of both the injector and the detector, too large sample sizes and, I might add, a much too thick stationary phase film. (These columns would be equivalent to a present-day "megabore" column of 0.53 mm i.d., having a film thickness of 9 µm.)

Dijkstra's work had been carried out independently of Golay's and he did not continue to work in this field. However, one of his developments survived: the way the capillary tubes were coated. He was the first to use the dynamic coating technique, wetting the inner wall of the tubing with the solution of the phase and then evaporating the residual solvent by maintaining a nitrogen stream through the tube for some time.

A number of other important papers also were presented at the symposium. Some theoretical papers further consolidated our knowledge on the Van Deemter equation. J. Bohemen and J.H. Purnell (Cambridge University, UK) and A.B. Littlewood (University of Durham, Newcastle, UK) gave detailed data on measurements related to the individual terms of this relationship obtained under different conditions, drawing conclusions about how (packed) column efficiencies could be improved. The very detailed discussion following these papers dealt with every aspect of column preparation and use, including even the best way to pack a column. Other theoretical papers dealt with the relationship between the

adsorption isotherms and chromatographic separation on adsorption columns and various other aspects of gas adsorption chromatography, as well as with the use of GC for the determination of activity coefficients.

The FID was not the only detector described at the meeting. Improvements to Scott's hydrogen flame (thermocouple) detector were presented by G.R. Primavesi, G.F. Oldham and R.J. Thompson (The Distillers Co., Epsom, Surrey, UK), while W. Struwe (Margarine-Union, Hamburg-Bahrenfeld, Germany) described a simplified thermal-conductivity detector. Van de Craats (Shell Laboratory, Amsterdam, The Netherlands) examined the quantitative aspects of this detector, its linearity and the ways of calibration, and D.W. Grant (Coal Tar Research Association, Leeds, West Yorkshire, UK) proposed a new type of detector in which the column effluent was mixed with coal gas, the mixture combusted, and the emissivity of the flame measured.

With respect to column technology, R.P.W. Scott's paper (Benzole Producers, Watford, Hertfordshire, UK) described highly efficient packed columns. The long (up to 50 ft) columns used with 200 psi inlet pressure could provide efficiencies up to 30 000 theoretical plates. L. Guild, S. Bingham and F. Aul (Burrell Corp., Pittsburgh, Pennsylvania, USA) reported on problems causing an unstable baseline, such as impurities in the carrier gas, fluctuation in its flow-rate and stationary phase bleeding when programming the temperature of the column. Temperature programming was discussed intensively, with prepared contributions by S. Dal Nogare (DuPont, Wilmington, Delaware, USA), C.L.A. Harbourn (BP, Sunbury-on-Thames, Surrey, UK) and K.E. Murray (Commonwealth Industrial Research Organization, Melbourne, Australia). G.F. Harrison, P. Knight, R.P. Kelly and M.T. Heath (Associated Ethyl Co., Ellesmere Port, Cheshire, UK) described a device to assure the controlled programming of column temperature and a system consisting of two columns in series where the second column was at a lower temperature to provide better separation of the lower boiling part of a wide-boiling-range sample.

Two papers dealt specifically with the design of gas chromatographs. The first, an automated preparative gas chromatograph, was developed by E.P. Atkinson and G.A.P. Tuey (May & Baker, Dagenham, UK). It utilized two 175-cm long, 2-cm i.d. columns in series, with a column packing consisting of 60/100 mesh kieselguhr support coated with 20–30% stationary phase. The important feature of the instrument was that it permitted the automated repetitive injection of the same sample and the joint collection of the same fractions from the repetitive injections. The second instrument, described by J. Hooimeijer, A. Kwantes and F. van de Craats (Shell Laboratory, Amsterdam, The Netherlands), was a process GC for automated control of pilot plant streams. It should be noted that by this time process gas chromatographs were already commercially available in the US and some of these have been described at the 1957 Lansing Symposium of the Instrument Society of America.

It is interesting to note that although by 1958 a number of gas chromatographs had become available commercially both in Europe and the US, none of these were described at the symposium in a contributed paper. During the Symposium an instrument exhibit was also held and the commercially available instruments were displayed there. The sensation of the exhibition was the Argon Gas Chromatograph of W.G. Pye &

Co. (Cambridge, UK) that utilized the argon ionization detector developed by J.E. Lovelock (National Institute for Medical Research, London, UK).²⁷ In fact, the interest in this system was so great that Lovelock was asked to present a brief description during one of the discussion sessions. This dual standard — that if an instrument was developed by a research laboratory, it was worthy of a formal presentation, but if it was developed by the instrument industry, it was considered commercial — was unfortunate, but it continued to characterize even future symposia.

Among the papers describing the applications of GC the presentation by L. Bovijn, J. Pirotte and A. Berger (Belgian Electrical Co., Schelle, Belgium) was the most interesting: using headspace analysis they determined traces of hydrogen in the water present in high-pressure boilers. Among the other papers, A. Liberti and G.P. Cartoni (University of Messina, Italy) surveyed the potential of GC in the analysis of essential oils, E. Bayer (Technical University, Karlsruhe, Germany) demonstrated the analysis of amino acid derivatives, and E.R. Adlard and B.T. Whitham (Shell Research Centre, Thornton, Cheshire, UK) illustrated the wide range application of GC for the analysis of high-boiling samples. Finally D. Ambrose (Chemical Research Laboratory, Teddington, Middlesex, UK) and J.H. Purnell (Cambridge University) presented retention data for a large number of compounds. They tabulated the values of the constants *A*, *B* and *C* in the Antoine-type equation

$$\log V_g = A + \frac{B}{t + C} \quad [2]$$

where V_g is the specific retention volume and t is the column temperature, in °C, for given temperature ranges on three stationary phases.

The Amsterdam Symposium started the tradition of having a reception for the participants and their spouses. Such receptions became a standard feature of future symposia; however, none of them could ever surpass Amsterdam. The reception was hosted by the Dutch government and the City of Amsterdam, and was held in the Rijksmuseum, one of the most famous picture galleries in the world. To stroll among the great paintings of Rembrandt and wait to have members of the militia to step out from their Night Watch and join the party was an experience I will never forget...

Acknowledgement

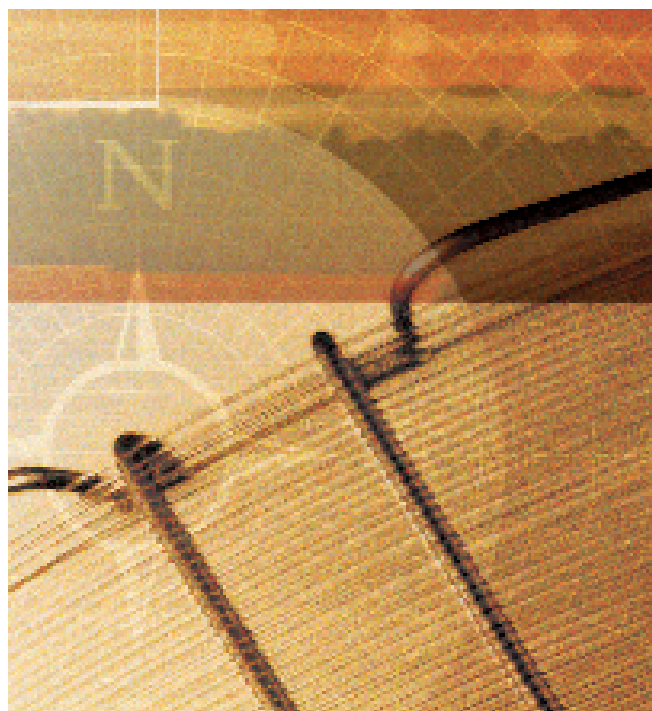
The description of the early history of gas chromatography in England was based on the plenary lecture on “50 Years of Gas Chromatography,” presented by E.R. Adlard at the 24th International Symposium on Chromatography (Leipzig, Germany, September 2002). Dr. Adlard also helped me with his recollections for which I am very grateful.

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